UNIVERSITY OF GONDAR
FACULITY OF VETERINARY MEDICINE

PREVALENCE OF OVINE AND CAPRINE SCHISTOSOMIASIS AND ITS ASSOCIATED RISK FACTORS IN MECHA DISTRICT NORTHWESTERN ETHIOPIA

DVM THESIS

BY
ASSFAW FENTANEW

JUNE, 2015
GONDAR, ETHIOPIA

UNIVERSITY OF GONDAR

FACULTY OF VETERINARY MEDICINE

PREVALENCE OF OVINE AND CAPRINE SCHISTOSOMIASIS AND ITS ASSOCIATED RISK FACTORS IN MECHA DISTRICT NORTHWESTERN ETHIOPIA

A thesis submitted to the Faculty of Veterinary Medicine, University of Gondar, in partial fulfillment of the requirements for the degree of Doctor of Veterinary Medicine

BY

ASSFAW FENTANEW BANTIDER

JUNE, 2015

GONDAR, ETHIOPIA

PREVALENCE OF OVINE AND CAPRINE SCHISTOSOMIASIS AND ITS ASSOCIATED RISK FACTORS IN MECHA DISTRICT NORTHWESTERN ETHIOPIA

BY

ASSFAW FENTANEW

DVM Thesis External Evaluators	**Signature**
1. Prof Abebaw Gashaw *School of Vet Med, Jimma University*	_____
2. Prof Tadelle Tolla *School of Vet Med, Jimma University*	_____
3. Dr Gelagay Ayelet (Assoc.Prof) *National Veterinary Institute /NVI/, Ethiopia*	_____
4. Dr Fufa Dawo (Assoc.Prof) *FVM, Addis Ababa University*	_____
5. Dr Ahimed Yassin(Assoc.Prof) *FVM, Wollo University*	_____
6. Dr Dessie Shiferaw(Assoc.Prof) *FVM, Hawassa University*	_____

Thesis advisor:

Dr. Samuel Derso (Asst.Prof) _____

TABLES OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AAPMDA	Animal, animal products and by-products market development authority
CDC	Center for disease control and prevention
CSA	Central Statistical Agency
FAO	Food and agricultural organization
FVM	Faculty of veterinary medicine
GDP	Gross domestic product
ILCA	International livestock center for Africa
mm	Millimeter
MWRDAP	Mecha woreda Rural development and agricultural planning office
SPSS	Statistical package for social science
WHO	World health organization

AKNOWLEDGEMENTS

I would like to express my deepest gratitude and heartfelt thanks to my advisor, Dr. Samuel Derso (DVM, MSC) for his providing of timely constructive comments, valuable suggestion and correction of this paper.

My sincere gratitude also goes to my parents and my brother (Abebe Fentanew) for their indispensable encouragement, financial and moral support throughout my academic year. I cannot write the whole what they have done for me within this paper.

I would like to acknowledge Bahir Dar University for its support by allowing computer service and other facilities for me until I finish my research activity.

Lastly, but not the least I feel honor to acknowledge my friends(Tadele Mossie)and all my class mates by providing their computer to write this paper and for their lovely cooperation during our stay in the campus respectively.

ABSTRACT

Schistosomiasis is a snail-born trematode infection of man and animal in tropical and sub tropical countries. It is an economically importance diseases caused by *Schistosoma* species and result in economic losses through mortality and morbidity from severe infection. A cross-sectional study was conducted from November, 2014 to April, 2015 in Mecha district Northwest Ethiopia. A total of 384 fecal samples were collected from randomly selected sheep and goat in three peasant associations. 'The sample was processed with sedimentation technique to detect *Schistosoma* eggs by using light microscope. Therefore, the overall prevalence *Schistosoma* infection irrespective of factors was found to be 9.4% (12.9% in ovine and 5.5% in caprine. In cases of sites where samples were collected, Kurtbahir showed higher prevalence (14.6%) than other two study sites Kudimi (8.4%) and Enamrt (4.2%). Age-wise prevalence of *Schistosoma* infection in sheep was significantly ($p<0.05$) varied. Similarly significant ($p< 0.008, 0.014$) association of *Schistosoma* infection with age and body condition score also observed in ovine population, not in caprine. Species-wise prevalence *Schistosoma* infection in sheep and goat was significantly ($p<0.05$) varied. However, *Schistosoma* infection did not affect ($p>0.05$) by sex in both species. From the result, it can be conclude that Schistosomiasis is one of the major health concerns of livestock production. Therefore, control of schistosomiasis based on drug treatment, snail control and appropriate sanitation measures were recommended.

Keywords: Small ruminants, Schistosomiasis, Snail, Sedimentation, Prevalence, Mecha

1. INTRODUCTION

Livestock production constitutes one of the principal means of achieving improved living standards in many regions of the developing world. In sub-Saharan Africa countries livestock plays a crucial role both for the national economy and the livelihood of rural communities. It provides draught power and raw material for industry (ILCA, 2007). In Ethiopia, livestock contribute about 30-35 % of agricultural gross domestic product (GDP) and 12-16 % of total GDP (AAPMDA, 1999).

Though Ethiopia is recognized for its vast wealth of livestock, the economic benefit derived from the livestock center does not commensurate with the potential (FAO, 1993). Development of large animal is constrained with certain infectious and non infectious diseases; among infectious diseases schistosomiasis contributes its own economic losses through reduction of the production and productivity potential of animals (Levere *et al.*, 2010).

Parasitism is of supreme importance in many agro-ecological zones and still a serious threat to the livestock economy worldwide. Sheep and goats are known to suffer from various endoparasites of which helminthes infection are of great importance (Vercruysse and Claerebout, 2001).

Schistosomiasis is snail-borne trematode infection of man, domestic animals and wild animals in different parts of tropical and sub tropical countries (Singh *et al*., 2004, and Islam *et al*., 2011). The major transmitting sites are small streams all over the highlands of Ethiopia, lakes like Tana, Zeway as well as irrigation systems, such as sugar state Wonji do also play a similar role (Shibru *et al.*, 1989).

Schistosomes are dioecious parasitic flatworms, which live in the vasculature of their mammalian definitive hosts. They are the causative agent of schistosomiasis, a disease of considerable medical and veterinary importance in tropical and sub-tropical regions (Rollinson and Southgate, 1993). Schistosomiasis is a chronic debilitating infection affecting both humans and animals by different species of *Schistosomes* and hence the disease is of public health importance. Other names given to schistosomiasis are blood fluke disease and Bilharziasis (Parija, 2004).

Although these parasites occur in many tropical and sub-tropical areas, the disease is important in livestock mainly in Eastern Asia, Africa and India. The distribution of schistosomiasis varies from

places to places. Example: *Schistosoma bovis* the commonest species in Africa and Mediterranean region (Aemro, 1993). However, *Schistosoma spindale, Schistosoma indicum* and *Schistosoma nasal* have been reported as the major causes of schistosomiasis in Asia (Bont, 1995). *Bulinus, Indoplanorbis* and *Planorbid* snail intermediate hosts are transmitting *Schistosomes* to cattle (Solomon, 1985).

The major transmitting sites are small streams all over the highlands of Ethiopia, lakes like Tana, Zeway as well as irrigation systems, such as sugar state Wonji do also play a similar role (Shibru *et al.*, 1989). The Districts bordering Lake Tana are relatively potential areas for livestock production due to availability of grazing land and enough water supplies; however, the area is highly infested with helminthes parasites particularly with *Schistosoma* parasite (Hailu, 1999). Koga dam and its surroundings give convenient ground for *Schistosoma* parasites and its intermediate host, snails, due to the water availability almost throughout the year and now days the irrigation practice for tomato, potato, onion and other crop farming practices of farmers. The transmission of schistosomiasis takes place only in the place where fresh water snail vector is present and where there is contact between the host and infested water (Okpala, 2004).

The Majority of studies done so far were bovine schistomiasis (Aemro, 1993, Hailu, 1999), however, there was no detailed studies on ovine and caprine schstosomiasis in Mecha district. Therefore, the objective of the present study was to estimate the prevalence of ovine and caprine schistosomiasis and to identify its associated risk factors in the Mecha district, Northwestern Ethiopia.

2. LITERATURE REVIEW

2.1. Descriptions of the parasite

2.1.1 Morphology

The *Schistosome* parasites are elongate, unisexual and dimorphic trematodes, which inhabit the blood vessels of their hosts. The female is slender and usually longer than the male and the female is carried in the gutter –like groove, the gynaecophoric canal of the male (Soulsby, 1982). The average length of adult male was (16.7± 1.3mm) and it had two suckers (oral and ventral) and distinct gynaecophoric canal and 3-6 testicles situated behind the ventral sucker, and in all specimens showed male holding the threadlike female in gynaecophoric canal. The egg was elongated spindle shaped with large terminal spine. The average size of the eggs was 266±11.6µ m length and 58±3.7µm width (Zangana and Aziz, 2012). The *Schistosomes* are different from most other members of the digenea, the sexes are separate. The term *Schistosom*e or *Schistosoma* means split body and refers to the fact that the males have a ventral groove called gynaecophoric canal (Marqurdt and Greive, 2000).

Figure 1: Morphological characteristics of adult *Schistosoma* (CDC, 2012).

2.1.2 Life cycle

Like many of the other trematodes, *Schistosomes* require an aquatic or amphibious snail as an intermediate host in order to complete their life cycle. The adult parasites live in the mesenteric veins of the final host. During the period of egg-laying, the female parasite enters the small vessels of the gut wall. The eggs, which have a sharp spine, penetrate the wall, enter the intestinal lumen and are passed out in the feces. Different snail species act as intermediate hosts. The development in the snail is similar to that of other trematodes. The infective forms released from the snails are free-swimming, fork-tailed cercariae. Infection of the final host takes place when the animal is drinking from a contaminated water source. Infection occurs either via skin penetration by the parasite, or by penetration of the digestive tract after ingestion of cercariae with the water. The immature flukes migrate through the lungs and the liver to the mesenteric veins, where they mature as indicated in figure 2 (Hansen and Perry, 1994).

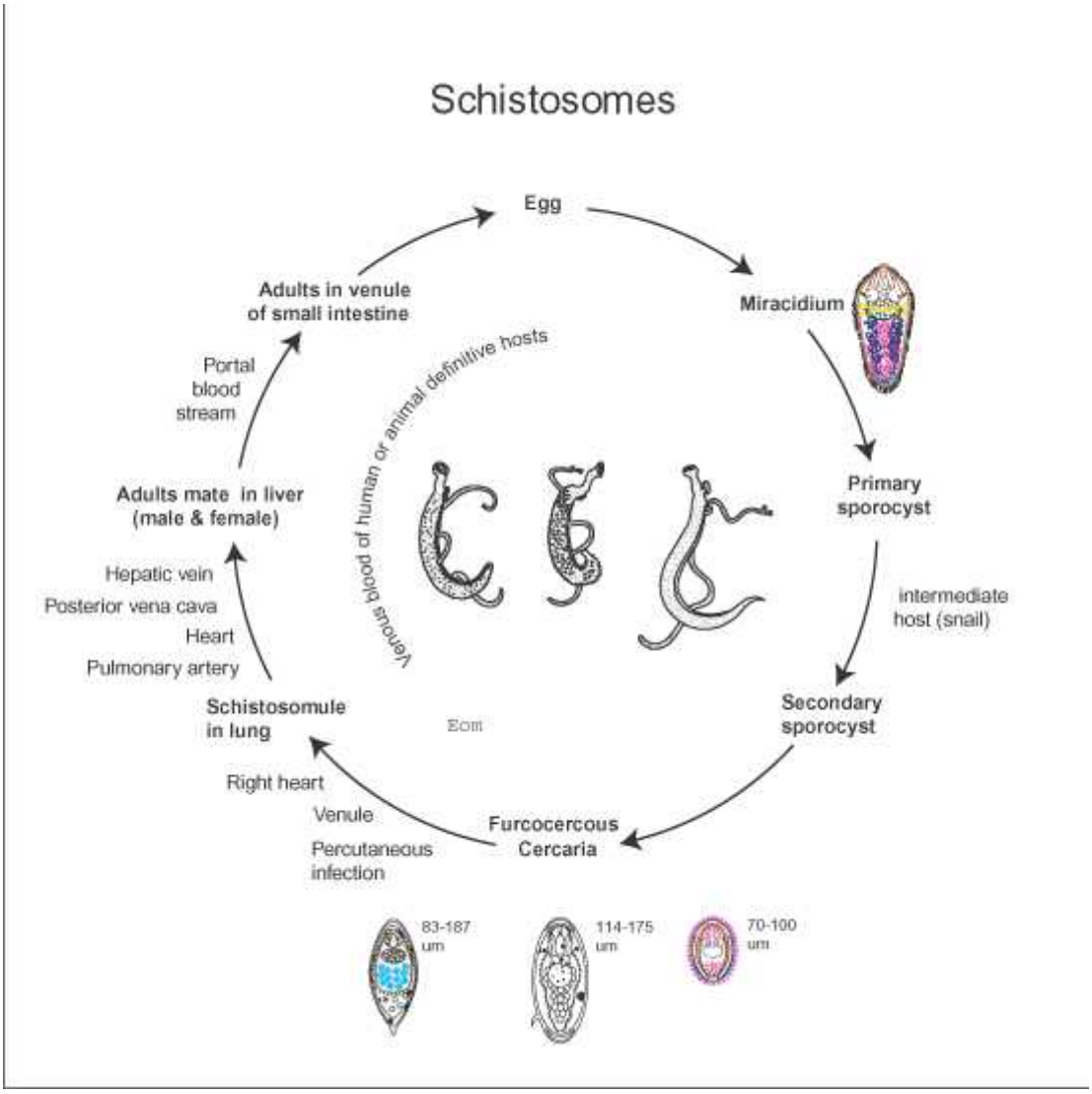

Figure 2: The life cycle *Schistosoma* in definitive and intermediate host (Brant *et al*, 2006).

2.1.3. Intermediate host

All *Schistosomes* need snails as their intermediate hosts to complete the asexual phase of their life cycles (Baugh, 1978). The snail intermediate hosts for bovine *Schistosomes* belong to the genus *Bulinus*, *Indoplanorbis* and *Planorbis*. An important genus in Africa is *Bulinus*. *Bulindis* are grouped into africanus group, truncatus/tropicus complex, forsicalli group and reticulates group (Bont, 1995).

Intermediate hosts of *Schistosoma mattheei* belong to the *Bulinus africanus* group while those of *Schistosoma bovis* belong to truncatus/tropicus complex as well as to the africanus group and farcically groups. In Ethiopia *Bulinus truncatus*, *Bulinus africanus* and *Bulinus abysinicus* serve as the intermediate hosts of *Schistosoma bovis*. *Schistosoma mattheei* has not been recorded in Ethiopia so far (Hailu *et al*., 1998). *Bulinus africanus* and *Bulinus truncatus* were identified harboring schistosoma cercariae confirmed by the experimental infection of mice with these cercariae. Other snails identified were *Biomphalari apfeifferi* and *Lymneanatalensis*. *Bulinus* species were identified at all sites. A higher infection rate was observed in snails collected from the Lake Tana whose population and infection rate decreased markedly after the month of February (Haile, 1987).

2.2. Etiology

Schistosomiasis is caused by a trematode worm of the genus *Schistosome* which resides in the mesenteric and portal veins causing various pathologies mainly acute intestinal syndromes and chronic hepatic syndromes (Haile, 1987).

Veterinary important species of Schistosoma that cause major impact on domestic animals include *Schistosoma bovis* (ruminants in Africa and Asia), *Schistosoma leiperi* (cattle in Africa), *Schistosoma spindale* (ruminants, horse and pigs in Asia), *Schistosoma nasale* (ruminants and horse in India), *Schistosoma indicium* (horse, cattle and goats in India buffalo), *Schistosomaja ponicum* (human,and mammals in Asia) and *Schistosoma margrebowiei* (horses, ruminants and elephants in Africa) (Kassaw, 2007).

2.3. Distribution

Schistosomiasis is a major source of morbidity and mortality for developing countries in Africa, South America, Caribbean, Middle East and Asia (Amy, 2005). Until recently, schistosomiasis in domestic animals was considered a minor disease. But in the last decades it has been found to be endemic in various countries including Northeastern, Central and Southern Africa, following great rivers and lakes (Haile, 2012).

Schistosoma species of animals are widely distributed in the tropical and sub-tropical region of the world. These include *Schistosoma bovis* commonly found in cattle, goat and sheep in Africa and Southern Europe, *Schistosoma mattheeii* normally parasite of sheep, cattle and other domestic animals in southern parts of Africa, *Schistosoma magrebowiei* in Antelopes in Central Africa and *Schistosoma rodhaini* normally parasitic in wild rodents and in carnivores in Eastern and Central part of Africa. Other species of veterinary importance in Asia include *Schistosoma spindale*, *Schistosoma indicum*, *Schistosoma incognitum*, *Schistosoma nasale* and *Schistosoma leiperi* (Hailu *et al*., 1998).

Schistosoma bovis has a localized distribution in Ethiopia and has been recorded in slaughter houses in various region of Ethiopia. The prevalence of *Schistosoma bovis* has reported from different regions of the country by fecal examination. For example, in Bahir Dar it was 33.8% report by Solomon (2008), 28% in Kemissie by Ameni *et al*. (2001) in cattle and 15.5% in Bahir Dar by Haile (2012) in small ruminants were evident.

2.4. Risk factors

Schistosomiasis is closely associated with large permanent water bodies such as ponds, lakes and marshy pastures. A key determinant in the epidemiology of this infection is the relative abundance of the intermediate hosts and their ability to develop and survive in the environment. Contamination of water with *Schistosome* eggs results when animal defecate in the water while drinking or if manure is used for feeding fish in ponds. As sheep and goats are reluctant to enter water, cattle are largely responsible for the transmission of the important *Schistosome* species. Cattle become infected through skin penetration and the oral route, whereas sheep and goats generally become

infected by drinking contaminated water. The type of watering facilities used by domestic stock is therefore, a crucial factor in the maintenance and transmission of the infection (Hansen and Perry, 1994).

2.5. Transmission

Various socio-epidemiological factors are responsible for transmission of schistosomiasis and level of infection. Among such factors are the following: distance from transmission site, migration and emergence of new foci, urbanization, socio-economic status, sanitation and intensification of farming, water supply pattern and level of fecal contamination of water source (Okpala, 2004). The main infection site of the final host is through skin penetration. Infection by ingestion is also possible when ruminants ingest cercariae or drink contaminated water (Hailu, 1999, Aemro, 1993).

2.6. Pathology and histopathology

Pathological lesions induced by *Schistosoma* consist of a granulomatous inflammation around the eggs trapped while traversing via tissues (Jones *et al*., 1997) despite the fact that Ethiopia has many wetlands that could favor snail multiplication, studies on animal schistosomiasis are scanty (Ameni *et al*., 2001). The gross pathological lesions of mesentery represented by presence of black spot or black streak on serosa of intestine and mesentery, paleness, enlargement of mesenteric lymph node and hepatomegaly also has been seen. Sever adhesion also has been seen between mesentery, intestine and abdominal muscles (Al-Kennany *et al*., 2009).

Hepatic tissue sections showed fibrosis in portal area and associated with congestion and coagulated necrosis in surrounded portal area, moreover vascular degeneration and fatty change had been seen in hepatocytes. The infected intestine revealed sever necrosis in mucosa and sub mucosa, and degeneration of epithelial villi and hyperplasia lining of sub mucosal glands, some of which changed into the compact mass, while others changed into cystic structure containing eggs of parasite. The histo-pathological change of mesentery arterioles and veinules revealed sever congestion and thrombophlebitis and deposition of the eggs with filtration of mononuclear cells and fatty necrosis. However, thickening in the wall of arterioles, presence of parasite in lumen of vein, inflammatory cells mixed with deposition of eggs and cross section of adult parasite in lumen of vein have been

also detected. There was emphysema with bronchopneumonia, severe congestion in pulmonary arteries and hyperplasia in the epithelial lining of bronchioles. There was depletion in some secondary lymph node follicle, periarteritis and infiltration of mononuclear inflammatory cell (monocyte) in medulla of the lymph node (Zangana and Aziz, 2012).

Histo-pathological section of mesentery tissue revealed presence of sever congestion in arterioles and veinules, thickness in the wall of arterioles due to presence of vacuole in all layers of arterioles, also thrombophlebitis have been seen associated with presence of cross sections of adult parasites in the lumen. Infiltration of mononuclear inflammatory cells in mesentery mixed with larvae and eggs. Liver section of sheep infected with *Schistosoma bovis* showed sever congestion of blood vessels perivascular cuffing of lymphocytes (minute granuloma),vascular degeneration and fibrosis in portal area associated with infiltration of mononuclear inflammatory cells (Al-Kennany *et al*., 2009).

2.7. Pathogenesis

The worm migrates from site of infection to portal and mesenteric veins, intestinal sub-mucosa and sub-serosal veins and lesser extent in pancreatic and branches of pulmonary artery (Hailu, 1999). The adult parasites are known to be haematophagus and the worm in the viscera can also causes tissue reaction when it is dead. The adult worms lay eggs in the mesenteric vein and as much as 40-80% eggs laid is retained inside the body and it is the retained eggs and their products that are responsible for most morbidity (Hailu, 1999).

2.8. Clinical signs

Schistosomes are found in the portal and mesenteric blood vessels, and the principal clinical signs are associated with passage of the spindle eggs through the tissue of the gut lumen. The young parasites cause some damage during migration, but most of the lesions are due to the irritation produced by the eggs of parasites in the intestine and other organs, and blood sucking habit of the helminthes worm. The helminthes worm may also enter the vesicles veins and they may cause hematuria (Soulsby, 1982).

Diseased animals shown unthriftness, anorexia, intermittent diarrhea mixed with blood, dehydration, sunken eyes, more over severe emaciation and thirst were also encountered. Systemic reactions were mild however; pale mucous membrane, polypnea and nasal discharge were also seen (Zangana and Aziz, 2012).

2.9. Diagnosis

Diagnosis is based primarily on the clinic-pathological picture, seasonal occurrence, and previous history of schistosomiasis in the area or the identification of snail habitats with a history of access to natural water bodies. Postmortem examination, hematological tests and examination of feces for *Schistosoma* eggs are useful (Urquhart *et al.,* 1997).

Definitive diagnosis of schistosomiasis is carried out by the detection of eggs in faces and/ or urine. Nevertheless, the parasitological methods of diagnosis have low sensitivity, especially animals with the acute phase of the illness or the low intensity infection (Taylor, C. and Wall, R, 2007). The demonstration of the characteristic eggs in the feces or squash preparation of blood and mucous from the feces is useful the period following patency but less useful as egg production drops in the latter stage of infection (Hailu, 1999).

The eggs of animal *Schistosoma* parasites differ in size and shape; oval in *Schistosoma japonicum* and spindle shape in *Schistosoma bovis* and *Schistosoma mattheei* containing single spine protruding from the shell. The position of the spine on the egg shell is a distinguishing feature; a rudimentary lateral spine in ova of *Schistosoma japonicum* and terminal spines in others. In general when Schistosomiasis is suspected, diagnosis is best confirmed by detailed postmortem examination which reveal lesion and if mesentery is stretched, the presence of numerous *Schistosom*es in the veins (Hailu, 1999). Nowadays, serological test may have great value in the diagnosis of schistosomiasis like enzyme linked immune sorbent Assay and electro immune transfer blot technique (Taylor, C. and Wall, R., 2007).

2.10. Treatment and control

Until the 1970's, treatment of schistosomiasis was nearly as dangerous as the diseases itself. Modern treatment is effective and without risk. According to world health organization a (2004), three new drugs (praziquantel, oxaminiquine and metrifonate) have revolutionized treatment of schistosomiasis. Praziquantel is a drug of choice but rapid reinfection is the problem (David, 1999).

Although schistosomiasis is not eradicable, the disease can be prevented and transmission controlled with a single annual dose of praziquantel (Donald, 2005). Main control options are the supply of pure drinking water, diagnosis and treatment of positive cases, management of the environment and control of the intermediate hosts or fresh water snails (WHO, 2004).

2.11. Socio-economic and public health importance

Schistosomiasis is one of the most prevalent parasitic diseases and an important public health problem in many developing countries. Globally, schistosomiasis ranks second among parasitic diseases of socio-economic and public health importance and is found in 48 African countries (WHO, 1999). An estimated 779 million people are at risk of schistosomiasis, of whom 106 million (13.6%) live in irrigation schemes or in close proximity to large dam reservoirs and the majority of these infections occur in Sub-Saharan Africa (Toure *et al.*, 2008).

The disease is mostly seen among the poor Sub-Saharan Africa. It is prevalent in tropical and sub-tropical areas especially in poor communities that had low access to safe drinking water and adequate sanitation. It is estimated that at least 90% of those requiring treatment for schistosomiasis live in Africa (WHO, 2012) It was listed among the 13 diseases classified by World health organization as "Neglected Tropical diseases (Hotez *et al*., 2007).

The three main species infecting humans are *Schistosoma haematobium*, *Schistosoma japonicum* and *Schistosoma mansoni*. Two other species, more localized geographically, are *Schistosoma mekongi and Schistosoma intercalatum.* Schistosomiasis in Africa is caused by an infection with *Schistosoma mansoni* and *Schistososoma haematobium* whose eggs may be found in feces or urine, respectively (CDC, 2012).

In Ethiopia, the prevalence of schistosomiasis infection varies from localities. The previous studies showed that the prevalence of *Schistosoma mansoni* among school children was 85% in Zarim, 67% in Gorgora (Moges *et al*., 2001), 5.95% among school children of different water source users in Tigray (Dejenie and Asmelash, 2010), 67.6% in Fincha valley (Haile *et al.*, 2012) and 20.6% among schooled children in Gorgora (Essa *et al*., 2013).

3. MATERIALS AND METHODS

3.1. Study area

The study was conducted from November, 2014 to April, 2015 in Mecha district Northwest Ethiopia. Mecha district is bordered with North Achefer, South Achefer and Ylmanadensa districts and having an altitude ranging from1800-2500 meter above sea level and has a warm humid climate with the annual rainfall vary from 1000-2000 mm. The annual temperature of the area ranges from 12.4^0c -21^0c. The area has poor drainage and there is annual over flooding during the rainy seasons leaving pockets of water bodies for long period during the dry season. Livestock population found in this district includes cattle, sheep, goat, horse, donkey and mule. The number of sheep and goat population in the district are estimated to be 148,971 and 18,659 MWRDAPO, (2012). Both traditional and modern (semi-intensive) farming are practiced in the study area.

3.2. Study animals

The study animals were sheep and goat randomly selected from randomly selected three peasant associations (kebeles) namely: Enamrt, Kudimi and kurtbahir. The study animals were indigenous breed sheep and goat both sexes (male and female) and two ages categories as described as (young and adult years). The age of animal was estimated by using dentition pattern of animals (young sheep≤ years and adult> 2 years) as described by Getenby, (1991), for goat (young≤3 and adult>3 years) (Steel, 1996). The body condition score was described as poor, medium and good as indicated by Mulugeta *et al*. (2014).

3.3. Study Design

A cross-sectional study design was conducted from November, 2014 to April, 2015 to estimate the prevalence of ovine and caprine schistosomiasis and to identify its associated risk factors in Mecha district, Northwest Ethiopia.

3.4. Sampling method and sample size determination

Simple random sampling method was applied to select study animals. During sampling informations like origin, species, sex, approximate age of individual animals and body condition was recorded. To calculate the sample size, the expected prevalence of 50% was considered by 95% confidence interval at an absolute precision of 5%. The desired sample size was calculated according to the formula given by Thrusfield (2005).

$$N = \frac{(1.96)^2 \times p_{exp}(1-p_{exp})}{d^2}$$

Where, n= required sample size.

$P_{exp=}$ expected prevalence.

d^2= desired absolute precision. Therefore, 384 sheep and goat were required for this study.

3.5. Coprological study

To determine the presence or absence of small ruminants' schistosomiasis, fresh fecal samples were collected from the rectum of each animal. Collected samples were placed in universal bottles containing 10% formalin for preservation and transported to Merawi veterinary clinic. Then samples were processed using sedimentation techniques as indicated by Hansen and Perry, (1994) in annex 4.

3.6. Data analysis

The collected data was entered and stored into Microsoft Excel spread sheet 2007. The data were thoroughly screened for errors and properly coded before subjecting to statistical analysis. The data were imported from the Microsoft Excel and analyzed using SPSS software version 16.0. Descriptive statistics was used to determine the prevalence of schistosomiasis and chi-square (x^2) was used to evaluate the association between the prevalence of ovine and caprine schistosomiasis with various risk factors (species, sex, age, origin and origin), p-value less than 0.05 or 5% level of significance were considered significant in this analysis.

4. RESULTS

Coprological examination of 384 samples indicated that 36 (9.4%) were positive for *Schistosoma* eggs. The prevalence of small ruminants' schistosomiasis between two species 12.9% in ovine and 5.5% in caprine was observed. The prevalence was greater in ovine than caprine and there was statistically significance variation ($p<0.05$) among two species. Similarly, over all infection rate in animals having poor body condition and adult age was significantly ($P<0.05$) higher than animals which have good and medium body condition and younger age. However, there was no significant association among sex group.

In the present study, it was observed that the prevalence of *Schistosoma* in relation with the sites of sample collected was significantly ($p<0.05$) varied. The prevalence for each kebele was 14.6%, 8.3% and 4.2% in Kurtbahir, kudimi and Enamrt, respectively (Table 1).

Table 1: The prevalence of schistosomia infection in small ruminants' and associated risk factors.

Risk factors		**Examined animals**	**Prevalence (%)**	$\mathbf{X^2_{(P\text{-}value)}}$
Site	Enamrt	119	5(4.2)	8.52(0.014)
	Kudimi	121	10(8.3)	
	Kurtbahir	144	21(14.6)	
Species	Caprine	183	10(5.5)	6.29(0.0012)
	Ovine	201	26(12.9)	
Age	Young	161	6(3.7)	10.41(0.001)
	Adult	223	30(13.5)	
Sex	Male	168	16(9.5)	0.008(0.93)
	Female	216	20(9.3)	
Body condition	Poor	147	23(15.6)	
	Medium	181	11(6.1)	11.34(0.0034)
	Good	56	2(3.6)	
Overall		**384**	**36(9.4)**	

Sex-wise distribution of *Schistosoma* infection was not significantly ($p>0.05$) varied, among sex group of sheep and goat. However, over all infection rate in male caprine (6.2%) was slightly higher than female caprine (4.9%). Whereas, it was slightly higher in female sheep (13.3%) than male sheep (12.5%) (Table 2).

Table 2: The prevalence of sheep and goat schistosomiasis based on sex

Species	**Sex**	**No. of examined animal**	**No. Positive**	**Prevalence (%)**	**$X^2_{(P\text{-}Value)}$**
Caprine	Female	103	5	4.9	0.17(0.68)
	Male	80	5	6.2	
Ovine	Female	113	15	13.3	0.26(0.87)
	Male	88	11	12.5	
Overall		**384**	**36**	**9.4**	

Age-wise distribution of *Schistosoma* infection was significantly varied ($p<0.05$) in adult and young sheep was found to be 18.9% and 3.8%, respectively. However, in adult and young goat it was found to be 6.9% and 3.6%, respectively. This is significantly varied ($p<0.05$) in adult and young sheep, but not significantly ($p>0.05$) varied in adult and young goat (Table 3)

Table.3: the prevalence of sheep and goat schistosomiasis based on age

Species	**Age**	**No. of examined animal**	**No. Positive**	**Prevalence (%)**	**$X^2_{(P\text{-}Value)}$**
Ovine	Young	78	3	3.8	
	Adult	122	23	18.9	9.66(0.008)
Caprine	Young	83	3	3.6	
	Adult	101	7	6.9	1.00(0.316)
Overall		**384**	**36**	**9.4**	

In the present study, it was observed that the prevalence of *Schistosoma* infection in relation with body condition score differ in ovine whereas it was not statically significant in caprine. Sheep with poor body condition score (21.5%) were more infected with *Schistosoma* than sheep with medium

(7.7%) and (7.3%) good body condition score. whereas in caprine, the highest prevalence were observed in poor body condition (8.8%) than medium and good body condition (Table 4).

Table. 4: The prevalence of sheep and goat schistosomiasis based on body condition.

Species	**Body condition**	**No. of examined animal**	**No. Positive**	**Prevalence (%)**	**X^2(P-Value)**
Caprine	Poor	68	6	8.8	
	Medium	85	4	4.7	3.314(0.19)
	Good	30	0	0	
Ovine	Poor	79	17	21.5	
	Medium	26	2	7.7	8.5(0.014)
	Good	96	7	7.3	
Overall		**384**	**36**	**9.4**	

5. DISCUSSION

The diagnosis of *Schistosoma* in animals and human beings is a key step to propose and establish control strategy (Niaz *et al*., 2010). According to Martin *et al* .(2008), and Zhou *et al*. (2008), determining target population for chemotherapy in endemic areas, assessment of morbidity and the evaluation of control strategy all can be built on the result from diagnostic test. Therefore, the present study was conducted to determine the prevalence and to identify risk factors associated with the occurrence of schistosomiasis in ovine and caprine population in the Mecha district, Northwest Ethiopia. Accordingly, the overall prevalence of *Schistosoma* infection in the present study animal was found to be 9.4%. The present finding was higher than the reports such as 1.7% Ferede *et al*.(2013), 1.5% Maritu *et al*. (2014), and 5.5% Lo and Lemma.(1973) in Southern and South western Ethiopia, Ravindran *et al. (*2008*),* 1.7% in South India, respectively. This difference might be due to the fact that the studies conducted in the previous covered very large area from where sheep could permanently or seasonally or not at all come in contact with water lodged area for dry season grazing and watering, whereas the present study covers small area where animals graze and watering around water lodged area (except for Enamrt which don't have specific stagnated water).

The difference in prevalence between the present study and the study conducted by Ravindra *et al.* (2008) in South India is due to difference in environmental factors (agro-ecology and climate), sampling time, epidemiological factors (availability of stagnant water body, marshy area and drainage system for irrigation practice which favor the development and multiplication of snail intermediate hosts) and agro-ecology, climatic conditions and animal management practices. However, the prevalence of the present study is lower than another previous study conducted in Lake Tana where in a prevalence of 20% was reported Haile. (1987) and Islam *et al*. (2011). This difference is because the present study included both marshy areas (Kurtbahir and Kudimi) and dry areas (Enamrt) but the current study was restricted only to Lake Tana which has higher stagnant water, lower drainage and predominantly marshy which is more favorable for the development and multiplication of snail intermediate hosts and environmental factor, sampling period, epidemiological factors.

The site- wise result of this study showed a significantly varied *(P*< 0.05), higher prevalence of ovine and caprine schistosomiasis in Kurtbahir (14.6%) than the other two peasant associations (Kudimi, 8.4% and Enamrt, 4.2%). This difference was due to swampiest and moisture nature of Kurtbahir than the other two. This may indicate that as the site is nearer to large stagnated water body due to this the infection rate becomes higher. Similarly, Urquhart *et al*. (1996) has reported that water lodged and poorly drained areas with acidic soils are often endemic for schistosomiasis.

Schisotoma infection rate in relation with age in the present study was varied in ovine but, not in caprine. *Schistosoma* infection was dependent on age and it was observed that higher prevalence in adults, this is similar with Islam *et al*. (2011) might be due to long exposure as because older animals move longer distance in search of scarce pasture and water there by, increase their chance of infection, on the other hand very young animals don't graze extensively as the older so they get less infection of cercaria.

Schistoma infection rate in relation with body condition score in present was varied ovine but, not in caprine. Animals with poor body condition score were more affected than other groups of animal. The reason might be related to the body defense mechanism of sheep and goat. This result agrees with Hailu (1999) and Merawe *et al*. (2014), in cattle schistosomiasis affirmed that infection rate increases with animals which have poor body condition score. This could be due to acquired immune status of poor body condition score and weak animals become more suppressed and susceptible which may be due to malnutrition and other parasitic infection. So, infected animals may require long period of time to respond against *Schisotom*a infection. This gives suitable time for establishment and fecundity of parasites in the animals.

In the current study, there was no statistically significant difference (p >0.05) in the infection rate between male and female animals of both species. This indicates that both sexes were have the same risk to acquire the infection. This is because of equal exposure to the risk factors as there was no restriction on movement for grazing and contact with the parasite in terms of sex. Small ruminants were seen grazing in the area that necessitates more contact times with the larval stage of the parasite and the snail intermediate vector. This creates ideal condition for the multiplication of *Schistosoma* and increases the epidemiology of the disease; Kassaw (2007) also reported that the

increased contact time with schistosoma infested habitat increases the rate and endemicity of schistosomiasis.

The prevalence of the *Schistosoma* infection among the two species (ovine and caprine) was vary and statistically highly significant differences ($p<0.05$) were observed. The prevalence of schistosomiasis was high in ovine (12.9%) than caprine (5.5%), this might be due to variation in the behavior and feeding system of animals as described by Agrawal and Sahastbudne (1982). Sheep visit regularly contact snail contaminated water when drinking. So, higher propensity for contact with drinking water as a source of contamination could explain high prevalence. Goat show distinct aversion to immersion in water even avoids walking through it. So this may reduce their potential for exposure.

6. CONCLUSION AND RECOMMENDATIONS

The prevalence of ovine and caprine schistosomiasis recorded in this study based on coprological examination revealed the presence of schistosomiasis in sheep and goat population of the study area at a considerable level. The study has revealed that occurrence of *Schistosoma* infection in sheep and goat was significantly affected by the origin of the animals, age, species and body condition status of the animals. In addition, the occurrence of the diseases is closely linked to the presence of bio-types suitable for the development and multiplication of intermediate hosts. Therefore, this study revealed that small ruminant's schistosomiasis was one of the major parasitic diseases contributing to loss in productivity and production of sheep and goat in the study area.

Based on this study, the following recommendations are forwarded:

- ✓ Schistosomiasis should be taken into consideration as one of the major limiting factor to livestock productivity in Mecha district hence any endeavor towards animal disease control strategy must include it in the priority list.
- ✓ Habitat modification and drainage or increasing of water flow activities should be practiced.
- ✓ Implementation of appropriate control measures for the intermediate host should be encouraged.
- ✓ Strategic use of anti-helminthes should be practiced to reduce pasture contamination with blood fluke eggs.
- ✓ Ant-helmentic drugs which effectively against *Schistosoma* should be widely available in veterinary clinic in the study area.
- ✓ Further and detailed studies on small ruminants' schistosomiasis and its intermediate host should be done in the study area.

7. REFERENCES

Aemro, T. 1993. Assessment of prevalence, economic significance and drug efficacytrial on bovine schistosomiasis in Bahir Dar, Ethiopia. DVM Thesis, faculty of veterinary medicine, Addis Ababa University, DebreZeit, Ethiopia.

Agrawal, M.C. and Sahastrabudhe, V.K. 1992. A note on natural heterologous schistosome infection in domestic animals. *Livestock Advisor*, **7**: 58-59.

Al-Kennany, E. R., Al-Hamoo, R. N., Al-Alaaf, E. Sh. 2009. Pathological study on sheep infected with *Schistosomabovis. Al- Anbar J. Vet. Sci.*, Vol: **2** No. (2), 2009, ISSN: 1999- 6527.

Ameni, G., Krok, B., Bogale, T. 2001. Preliminary study on major bovine trematode infection around Kemissie, Northeastern Ethiopia and treatment trial with praziquantel. *Bull. Anim. Hlth. Prod. Afr*, **49**: 62-67.

Animal, animal products and by-products Market Development Authority (AAPMDA), 1999. Market Problems and Measures to Be Taken.

Baugh, S. C. 1978. Cited by Southgate, V.R and Agrawal, M.C. Schistosomiasis in India.*Parasitol.Today*, **6**: 166-168.

Bont, J.D., 1995. Cattle schistosomiasis. Host-parasite interaction.PhD thesis, Universities, Gent, p. 23-27.

Brant, S. V.; Morgan, J. A. T.; Mkoji, G. M. 2006. "An Approach to Revealing Blood Fluke Life Cycles, Taxonomy, and Diversity: Provision of Key Reference Data Including DNA Sequence from Single Life Cycle Stages". *Journal of Parasitology* **92** (1): 77–88.

CDC, 2012. Parasite and health. Schistosomiasis. http//www.dpd.cdc.gov/dpdx/HTML/ Schistosomiasis.htm.

CSA., 2008. Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural Sample Survey 2008/09. Vol.2. Report on Livestock and livestock characteristics.

David, D. 1999. Parasitic Diseases Lectures 34-37. Cambridge MPD parasitology lecture notes.

Dejenie, T. and Asmelash, T., 2010. *Schistosomamansoni*among school children of different water source users in Tigray, Northern Ethiopia. *Momona Ethiopian Journal of Science*, **2**: 49-60. doi:10.4314/mejs.v2i1.49650.

Donald, G. McNeil, Jr. 2005. Schistosomiasis (Bilharzia) control and prevention. The Carter Center schistosomiasis control program.

Essa, T., Birhane, Y., Endris, M., Moges, A., Moges, F. 2013. Current status of *Schistosomamansoni*infections and associated risk factors among student in Gorgora town, Northwest Ethiopia. *Infectious Diseases*, 2013, Article ID 630103.

FAO, 1993. Agricultural statistical data. Statistics division, Rome, Italy.

Ferede, Y., Amane, A., Mazengia, H., Mekuriaw, S. 2013. Prevalence of major ovine diseases and analysis of mortality in selected model sheep villages of south Gondar administrative zone, Ethiopia. *Open Science Repository Veterinary Medicine*, Online (open-access), e23050426. doi:10.7392/openaccess.23050426.

Gatenby, R. 1991.Sheep:The tropical agriculturist, London and MACIL LAN.Education Ltd,Acct.p7.

Haile, S. 1987. Schistosomiasis in domestic ruminants in Bahir Dar. Proceedings of the first National livestock improvement conference, Addis Ababa, Ethiopia. Pp; 122-124.

Haile, S., Golassa, L., Mekonnen, Z. 2012. Prevalence of *Schistosomamansoni*and effectiveness of Praziquantel in school children in Fincha valley, Ethiopia. *Journal of Parasitology and Vector Biology*, **4**: 25-30.

Hailu, B., Shibru, T., Leykun, J. 1998. Schistosomiasis in Ethiopia and Eritrea. Institute of pathobiology, Addis Ababa University, 3rd edition.

Hailu, M. 1999. Observations on the prevalence and intensity of Schistosomabovis infection in Bahir Dar area, north central Ethiopia. DVM Thesis, Faculty of veterinary medicine, Addis Ababa University, DebreZeit, Ethiopia.

Hansen, J. and Perry, B. 1994. The Epidemiology, Diagnosis and Control of Helminth Parasites of Ruminants. International Livestock Center for Africa, Addis Ababa Ethiopia, P. 90-100.

Hotez, P.J., Molyneux, D.H., Fenwick, A. 2007. Control of neglected tropical diseases. *The New England Journal of Medicine*, **357**: 1018-1027. Doi: 10.1056/NEJMra064142.

ILCA, 2007. Annual Report. Addis Ababa, Ethiopia, pp: 34-38.

Islam, K.S. 2011. Schistosomiasis in domestic ruminants in Bangladesh. Tropical Animal Health and Production, 7(4): 244-248.

Jones, T.C., Hunt, R.D., King, N.W. 1997. Veterinary pathology, 6 ed. Lippincott Williams and Wilkins, Maryland, pp: 664-667.

Kassaw, A. 2007. Major Animal Health problems of market oriented livestock Development in FogeraWoreda. DVM Thesis, FVM, Addis Ababa University, DebreZeit, Ethiopia.

Kassuku, A.A. 1985. Field demonstration of resistance to natural challenge infections in *Schistosomabovis infected* dairy cattle. ISSN: 0856-1575. Proceedings of the 3rd Tanzaniaveterinary association scientific conference, Tanzania veterinary association, volume 3 pp: 77-84.

Lefevre, C. Blancou, j., Chermette, R. and Uilenberg, G. 2010. Infectious diseases of livestock.1st ed. *Paris. Lavoizer*, **2**, P.1697-1703.

Lo, C.T and Lemma, A. 1973. A study on schistosoma bovis. Annals of Tropical medicine and Prarasitology, 69, p.375-382.

Majid, A. A, Marshalla, T. F. de C., Hussien, M. F., Bushara, H. O., Taylor, M. G., Nelson, G. S., Dargie J. D. 1980. Observation on cattle schistosomiasis in the Sudan, a study on comparative medicine. Epizootological observation on *Schistosomabovis* in the White Nile Province. Am. J. Trop. Hyg.**29**: 435-441.

Merawe, M., Amssalu., K, Hagos, Y. and Afera, B.2014. Intestinal Schistosomiasis of Bovine and Ovine in Fogera district, South Gondar zone, Amhara National Regional state,Ethiopia. *Acta parasitological Globalis* **5**(2): 87-90.

Marqurdt, C.R. and Greive, B.R. 2000. Parasitology and vector biology.2nd ed. Sandiago. Harcourt academic press, pp: 265-272.

Maritu, M., Kassaw, A. Yonas, H. and Berihun, A. 2014.Intestinal Schistosomiasis of Bovine and Ovine in fogera distric,South Gondar Zone, Amhara National Regional state,Ethiopia. *Acta Parisitology Globalis* **5(**2) 87-90.

Martine, J., Anna, C., Critian, L, Coeho, P. and Schall, V. 2008.Acombined stratagem to improve the controle Schistosomiasis in area of low prevalence in Brazil. *American Journal of Tropical Medicine and Hygiene* **78**(1):144-146.

Mecha woreda, Rural development and agricultural planning office, (MWRDAP), 2012.

Moges, T., Mesganaw, F., Afework, K., Gebeyaw, T., Van Lieshout, L., Polderman, A.M. 2001. *Schistosomamansoni*in school attenders and non-attenders in Northwest Ethiopia. *Ethiopia n Journal of Health Development*.**15**: 117-123.

Mulugeta, Y., T.H. Yacob and H. Ashenafi, 2010. Ectoparasites of smalll ruminants in three selected agro Ecological sites of Tigray Region, *Ethiopia. Tropical Animal Health and Production*, (42), 1219- 12.

Niaz. S., Tenveer., A and Qureshi, A. 2010.Prevalence of schistosomiasis in cows and buffaloes at different sites of Punjab Pakistan and its relation to temperature, relative humidity, rain fall and PanEvaporation. *Pakistan Journal of Science* **62**(4):242-249.

Okpala, HO. 2004. A survey on the prevalence of schistosomiasis among pupils in Apata and Laranto areas in Jos, Plateau State. Volume 3, issue 1. Federal College of Veterinary and Medical Laboratory Technology, National Veterinary Research Institute, Vom, Plateau State, Nigeria.

Parija, C.S. 2004. Text book of parasitology, protozoology and helminthology. 2nd ed. Chennai: AIPD, pp: 141-256**.**

Ravindra, R**.,** Lakshmanan, B**.,** Ravishankar,C. and Subramanian, H.,2008. Viscral schistosomiasis, Amonge Domestic animals, in Wanyanad, South India.

Reinecke, R.K. 1989. Phylum platy helminthes veterinary helminthology, Pretoria:Butterworth, Pp. 245-248.

Rollinson, D. and Southgate, V.R. 1993. The Genus Schistosoma. A taxonomic appraisal. In D. Rollinson and A.J.G Simpson (E Ds), the biology of Schistosomes form genus to latrines London: Academic press, pp: 1-49.

Sangma, A., Begum, N., Roy, B.C., Gani, M. O. 2012. Prevalence of Helminth parasites in sheep (*Ovisaries*) in Tangail district, Bangladesh.J.BangladeshAgril. Univ. 10(2): 235–244, 2012, ISSN 1810-3030.

Shibru, T., Getachew, T., Hailu, B.1989. Parasitology. Schistosomiasis in Ethiopia. Addis Ababa. Addis Ababa printing press, pp: 18-26.

Singh, A., and Chaudhri, S. 2004.Visceral Schistosomiasis of domestic animals in India:humoral immune status of infected cattle, sheep and goat against mainy poly peptide antigens of *Schistosoma indicum and Schistosom spidle.parsite and immunology* ***26:***167-175.

Solomon, A. 2008. Prevalence of Bovine schistosomiasis in and around Bahir Dar. DVM Thesis, FVM, Mekelle University, Mekelle, Ethiopia.

Solomon, H. 1985. Schistosomiasis in domestic ruminants in Bahir Dar, Ethiopia. DVM Thesis, faculty of veterinary Medicine, Addis Ababa University, DebreZeit, Ethiopia.

Soulsby, E.J.L. 1982. Helminthes, Arthropods and Protozoa of Domesticated Animals. 7th edition.BaillierTindall. Pp: 78.

Steel, M. 1996. Goats, Tropical, Agriculturalist, Macmillan Education Limited, London and Basiastoke. P1-2.

Taylor, C. and Wall, R. 2007.Veterinary Parasitology. 3 ed. UK: Blackwell, pp: 91-93.

Thrusfield, M. 2005. Veterinary epidemiology 2nd edition UK, Black well science, pp. 182-189.

Touré, S., Zhang, Y., Bosqué-Oliva, E., Ky, C., Ouedraogo, A., Koukounari, A., Gabrielli, A.F., Sellin, B., Webster, J.P., Fenwick, A. 2008. Two year impact of single praziquantel treatment on infection in the national control program on schistosomiasis in Burkina Faso. *Bulletin of the World Health Organization*.**86**, 780-787.

Urquhart, G.M., Armour, J., Duncan, J.L., Jenning, F.W. 1996. *Veterinary helminthology*, *Veterinary parasitolog*y. New York ChurchillLivingstone Inc. pp. 114-116.

Urquhart, G.M., Armour, J., Duncan, J.L., Jennings, F.W. 1997.Veterinary helminthology, veterinary parasitology. New York ChurchillLivingstone Inc. p. 114-116.

Vercruysse, J. and Claerebout, E. 2001. Treatment vs. non-treatment ofHelminth infections in cattle. Defining the thresholds.*Veterinary Parasitology*, 98: 195-214.

WHO, 2012. Schistosomiasis. http://www.who.int/mediacentre/factsheets/fs115/en/index.html.

WHO, 2004. Prevention and control of schistosomiasis and soil transmitted helminthiasis. Joint statement.WHO/CDS/CPE/PVC9. WHO, Geneva: 1-4.

WHO., 1999. Report of the WHO informal consultation of schistosomiasis control. WHO/CDS/SIP/99.2, WHO, Geneva.

Wubet, S and Thomas, C., 2006. Preliminary study on the epidemiology of schistosomiasis and its intermediate hosts around Lake Tana. AmharaNational Regional State Bureau of Agriculture Bahir Dar Regional Veterinary Laboratory.Bahir Dar, Ethiopia.

Zangana, I. and Aziz,K. 2012. Prevalence and pathological study of Schistosomiasis in sheep in Akra(Dohuk province, North Iraq. *Iraq Journal of veterinary Science* **26**:125-130.

Zhou, X., Guo, Y., Hong, Q. and Sun, L., 2008. Potential impact of climate change on schistosomiasis transmission in china. *America socity of Tropical Medicine and Hyginene*, 78(2), p. 188-194.

8. ANNEXES

Annex 1: sample collection sheet

No	Date	Spp of animal	Age	Sex	Bcs	origin	Result	
							+ve	-ve
1.								
2.								
3.								

Annex 2: estimated age for sheep and goats with different number of erupted permanent incisors.

No of permanent incisors	Estimated age range	
	Sheep	Goat
0 pair	less 1 year	under 1 year
1 pair	1-1$^{1}/_{2}$ years	1-2 years
2 pairs	1$^{1}/_{2}$-2 years	2-3 years
3 pairs	2$^{1}/_{2}$-3 years	3-4 years
4 pairs	>3 years	>4 years

(Source: Gatenby, 1991 And Steel, 1996).

Annex 3: estimated body condition for sheep and goat

Body condition score	descriptions
Poor	sheep and goat that was extremely thin to these with smooth and less prominent spinous process, transverse process in Which finger can be pushed and these having moderate depth of loin muscle
Medium	when the spine passes can be felt with very firm pressure and they were rounded rather than sharp the eye muscle areas has full with moderate fat cover
Good	sheep and goats on which spinous process only stick up very slightly, smooth rounded and well covered transverse process and these having full, Loin muscles and very fat

(Source: Mulugeta *et al*., 2010).

Annex 4: **Laboratory techniques for sedimentation methods** (Hansen and perry, 1994)

- Weigh or measure approximately 3gm of faeces into contiainer and mix with 40-50 ml of tap water
- Mix(stir) thoroughly with a stirring device and filter the suspension through through the tea strainer or double layer of cheesecloth into another container
- Pour the filtered material into a test tube and leave it for 5 minutes to sediment
- Remove the supernatant very carefully and resuspend the sediment in 5 ml of water and leave it for 5 minutes to sediment
- Again discard the supernatant very carefully and take a small amount of sediment by using pipette and drop on the microscope slide
- Then cover with the cover slip and examine it under a microscope at a magnification 100x for trematodes egg.

9. DECLARATION

I, the under signed, declare that the information presented here in my thesis is my original work, has not been presented for degree in any other university and that all sources of materials used for the thesis have been duly acknowledged.

Name: Assfaw Fentanew
Signature: …….
Dates of submission: …….

This thesis has been submitted for examination with my approval as university advisor
Name: Dr. Samuel Derso (DVM, MSc)
Signature……